Calibre 2024.3 Release Highlights

Calibre Semiconductor Manufacturing Solutions

Aug 2024

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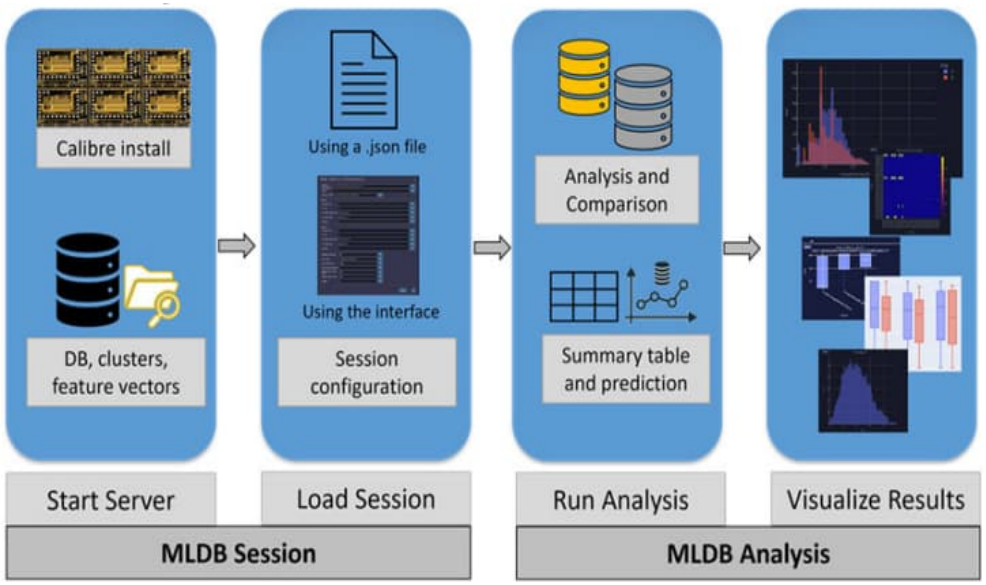
Calibre MLDB Xpert – New Infrastructure for All Tools Supporting Machine-Learning Data Base (MLDB)

New Product!

- Calibre MLDB Xpert is a data analytics and visualization tool, which analyzes and visualizes cluster and feature vector machine learning databases from Calibre SONR.
- Calibre MLDB Xpert provides great usability in creating session configuration, cluster comparison, heatmaps and feature histogram.
- To invoke Calibre MLDB Xpert, enter the following command in a terminal window:

mldbdash [options]



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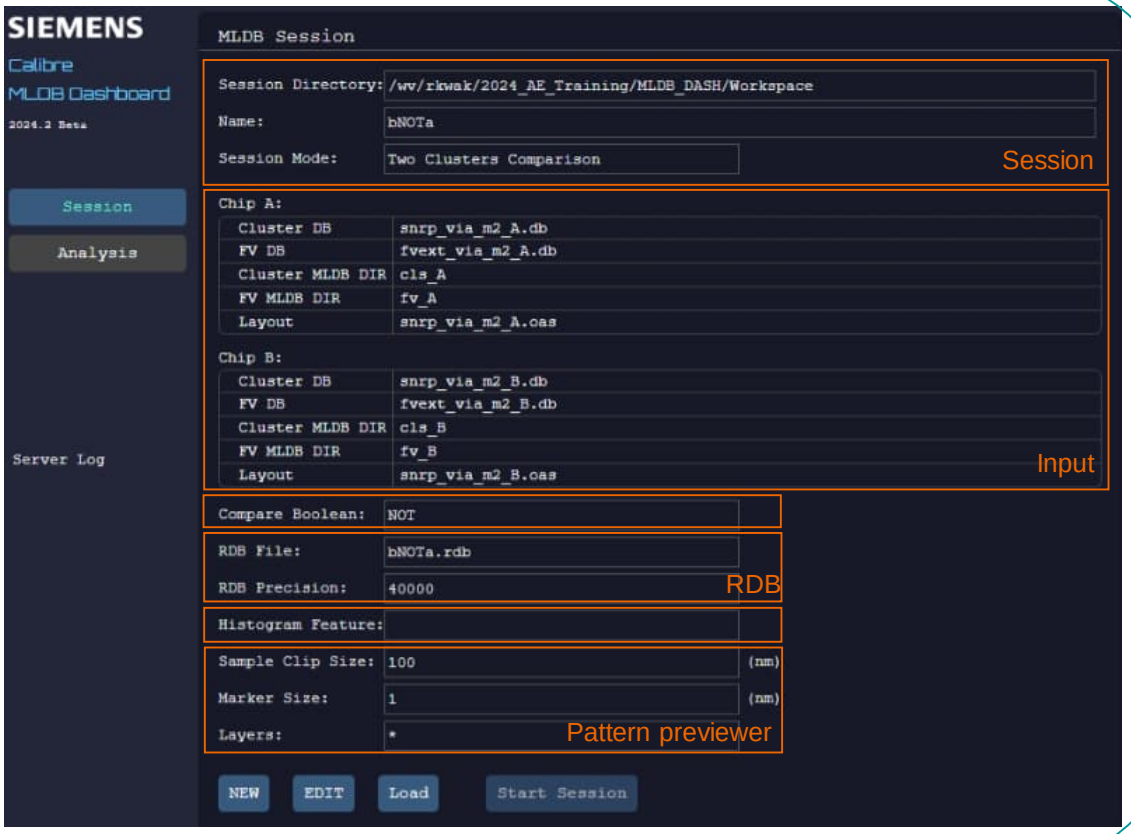
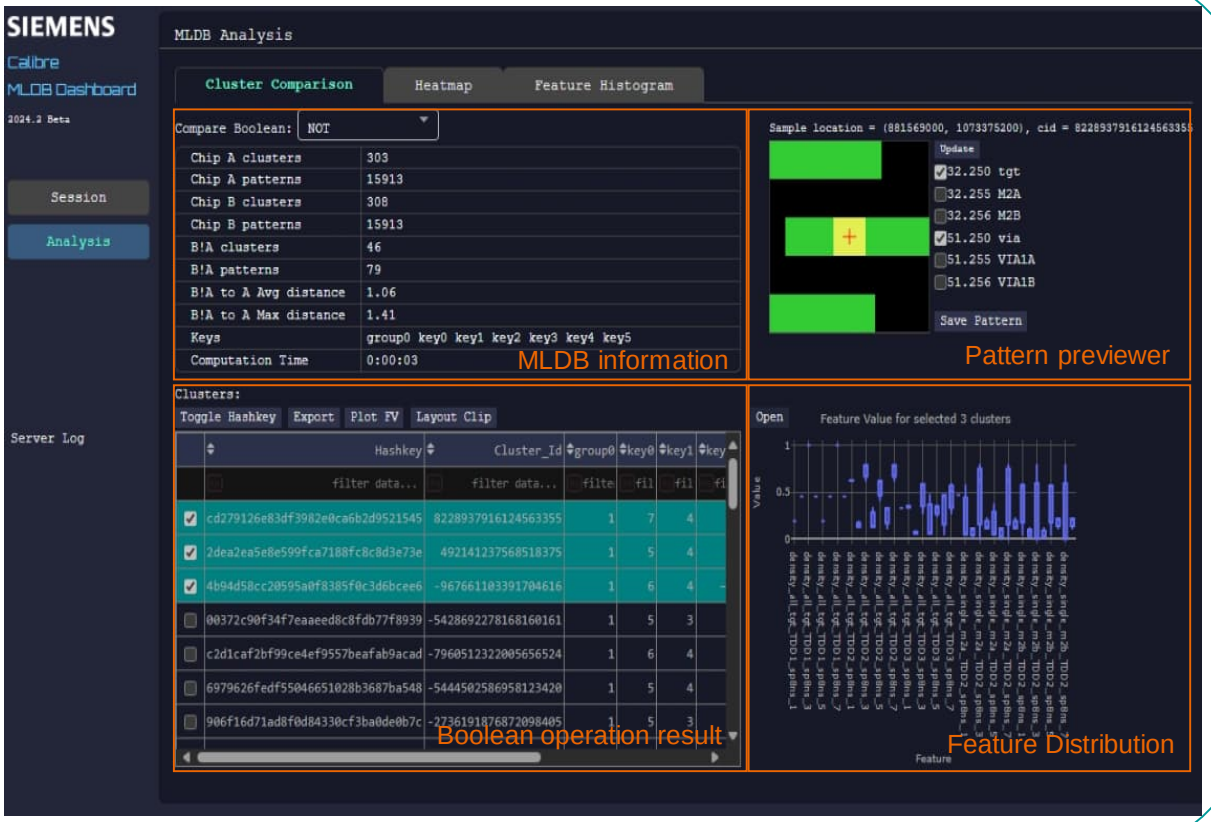
Calibre MLDB Xpert – Session Configuring

- Users specify the analysis session configurations which include:
  - Session directory, name, and mode
  - Input for two chip information
  - Boolean operation
  - Output file path and precision
  - The feature in the database to output a histogram for.
  - Size of the output sample clip, size of markers for clips, and the layers to output

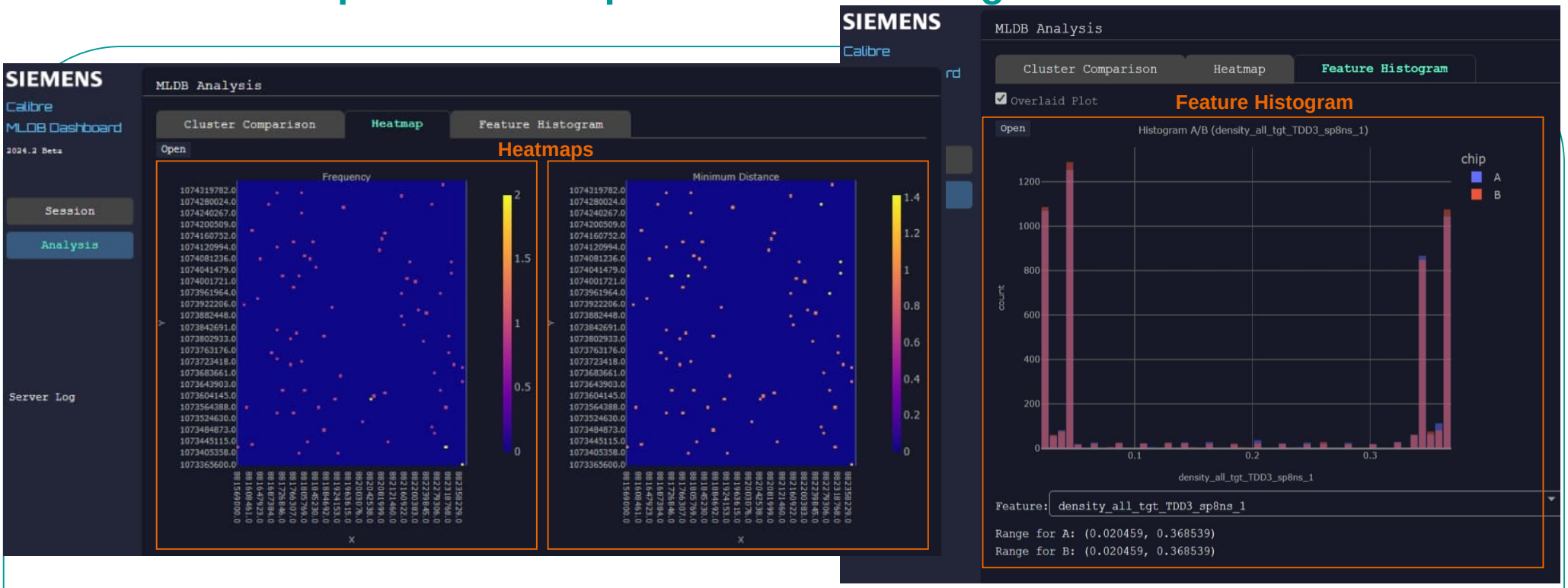


Calibre MLDB Xpert – Cluster Comparison

- Users can perform cluster comparison from the GUI.
  - MLDB information is summarized, and Boolean operation results are displayed.
  - From the analysis controls, users can
    - write the cluster list to a CSV.
    - display a simple feature value plot based on a selected cluster.
    - display a small window of layout.
- Users can save and update patterns in the pattern previewer as well as create a feature distribution using a boxplot.



Calibre MLDB Xpert – Heatmap and Feature Histogram



- Heatmap shows the frequency of unique clusters, feature vector points, or features occur in the object being analyzed.
- Feature histogram can be created to compare between two chips for one specified feature.

New Calibre Interactive GUI for DFM - LFD

- Starting in 2024.3, users can optionally run Calibre LFD from the updated Calibre Interactive GUI for DFM by setting an environment variable. This GUI is streamlined and configurable with similar options and settings to the default classic Calibre Interactive GUI.
- To enable the updated Calibre Interactive GUI for DFM, set the required environment variable. For example, using csh:

```
setenv CALIBRE_ENABLE_NEW_CI_DFM 1
```

- To invoke the Calibre Interactive for DFM GUI from a command line:

```
calibre -gui -dfm
```

- To invoke Calibre Interactive for DFM GUI from a supported layout viewer or design tool with a Calibre interface and an open layout, for example, in Calibre DESIGNrev:

Verification > Run DFM

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Enhancements for Calibre LSG DRM-Mode

New `Reference` option (Design Style File)

- Users can now specify the `Reference` keyword with the `Start`, `Center`, or `End` keyword.
- This determines whether the placement location for a preferred direction wire is measured from the bottom boundary of the highlight layer to the start (default), center, or end of the track.
- For example:

```
PDWire
    {
        Width  { 0.06; 0.10; 0.14 }
        Length { 0.18:2  }

   PlacementLocations {
     Reference {Start}
     {Width {0.06} Locations {0.006:4:0.01} }
     {Width {0.10} Locations {0.002:4:0.01} }
     {Width {0.14} Locations {0.006:4:0.01} }
     }

   }
```

Updates to Save behavior (Rule Creator GUI)

- The behavior for the Save menu functionality now enables users to save user-defined rules generated from the Rule Creator GUI to separate files with unique names.
- When updating and saving a rule file generated from the Rule Creator GUI, the Save functionality prompts the users to either rename the file or overwrite the existing file with the same name.

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New Auto Model Creator Utility in Calibre SONR

- New auto model creator runs multiple trials to tune hyperparameters before creating the actual model. It uses the hyperparameter settings that produced the best model in the trials to produce the final supervised machine learning model.
- The example creates a fully supervised machine learning model. It runs 40 trials to determine the best hyperparameters before creating the actual supervised machine learning model.

```
sonr --model_creator auto_model_2 --i sonr_collect.db
--f sonr_collect.mod --l pinch --trial 40
```

```
================================================================================
                        2. Initializing model.
================================================================================
[logging]                                        2024-06-07 17:27:16.125152
Initializing model.
[ status ] Searching for the best ML model
[ status ] Search 0 started.
[ status ] Search 0 completed with score: 0.5333. Current best is: 0.5333
[ status ] Trial 0 finished with value: 0.533333.
[ status ] Currently found best is trial 0 with value: 0.533333.
[ status ] Search 1 started.
[ status ] Search 1 completed with score: 0.5333. Current best is: 0.5333
[ status ] Trial 1 finished with value: 0.533333.
[ status ] Currently found best is trial 0 with value: 0.533333.
[ status ] Search 2 started.
[ status ] Search 2 completed with score: 0.625. Current best is: 0.625
[ status ] Trial 2 finished with value: 0.625.
[ status ] Currently found best is trial 2 with value: 0.625.
[ status ] Search 3 started.
[ status ] Search 3 completed with score: 0. Current best is: 0.625
[ status ] Trial 3 finished with value: 0.
[ status ] Currently found best is trial 2 with value: 0.625.
...

[ status ] Trial 38 finished with value: 0.823529.
[ status ] Currently found best is trial 38 with value: 0.823529.
[ status ] Search 39 started.
[ status ] Search 39 completed with score: 0.6316. Current best is: 0.8235
[ status ] Trial 39 finished with value: 0.631579.
[ status ] Currently found best is trial 38 with value: 0.823529.
[logging] Elapsed time for step 2:              00:01:51.40
[logging] Elapsed seconds for step 2:           111.40
[logging] Total elapsed time:                   00:02:19.66
[logging] Total elapsed seconds:                139.66
[logging] Available / Total Virtual Mem (MB):   28612.613  31887.457
[logging] Cur / Max RSS (MB):                   598.746  625.387
```


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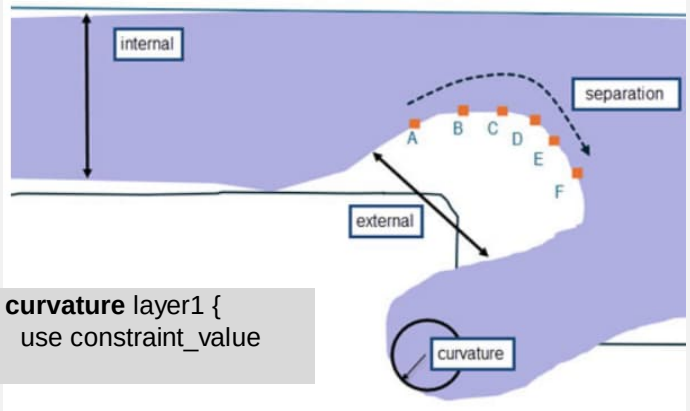
New Features in Calibre OPC Solutions

New curvature check in Calibre nmCLOPC




```
cl_mrc_rule curvature layer1 {
                use constraint_value
}
```

New options for curved-based anchor point insertion in Calibre nmCLOPC

- New keyword specifies the minimum change of direction a curved section must have in order to have anchor points inserted.
- New keyword ensures the minimum separation is maintained in cases where the curved region is small, and anchor points may be too closely placed.

anchor_point_layer .. ap_curve… [**-angle_filter_threshold** degrees] [**-enforce**]

New options for outputting sites associated with anchor points

- The `POINTSET_SITES_DUMP` command has new options to output square markers to indicate where the EPE for a process window intersects the control site, and to preserve the orientation of small sites.

POINTSET_SITES_DUMP… [**-epe** process_window_name] [**-force_directional_sites**]

New keywords in tagging controls

- New arguments `corner1_tol` and `corner2_tol` in `NEWTAG edge` and `NEWTAG fragment` prevent an angle between two edges or fragments being treated as a corner if the angle is less than degrees from 180.
- This can be especially useful for Calibre nmCLBIAS Gen 1.

Sites creation and deletion for etch EPE

- The `SITES_CREATE` and `SITES_DELETE` commands add a new type, `ETCH_EPE`, so that rules can work explicitly with etch sites instead of creating them indirectly with `SITES_DUMP`.

New command for curvilinear biasing

- New command, `curvilinear_jog_angle_threshold`, controls the insertion of jogs between adjacent, almost-collinear fragments.

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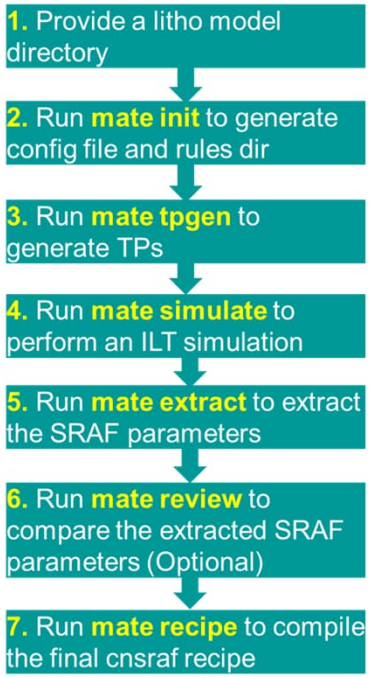
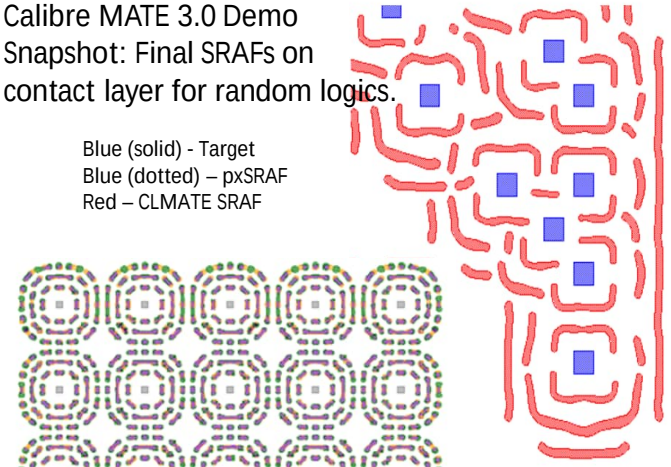
Reorganized Model-Assisted Template Extractor (MATE 3.0) for CNSRAF Development

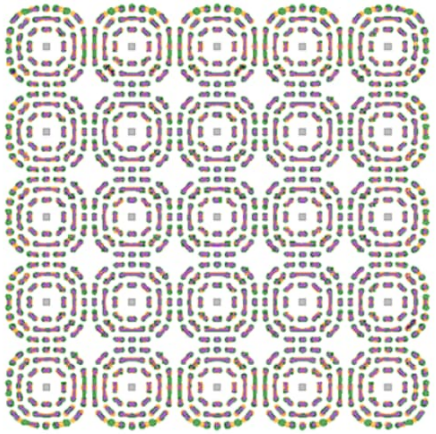
- Calibre MATE is restructured to operate on a single test chip design, leveraging Calibre's built-in parallel execution mechanism (MTFlex) to perform all simulation & extraction operations in parallel.
- MATE 3.0 reduces the development time and expertise needed for template-based (cnsraf) rule development by automating the workflow.
- MATE 3.0 and curvilinear SRAF templates ensure quality curvilinear SRAF insertion.



Calibre MATE 3.0 Workflow

Calibre MATE 3.0 Demo Snapshot: Final SRAFs on contact layer for random logics.




Coverage check between ILT and cnsraf SRAFs on training patterns.

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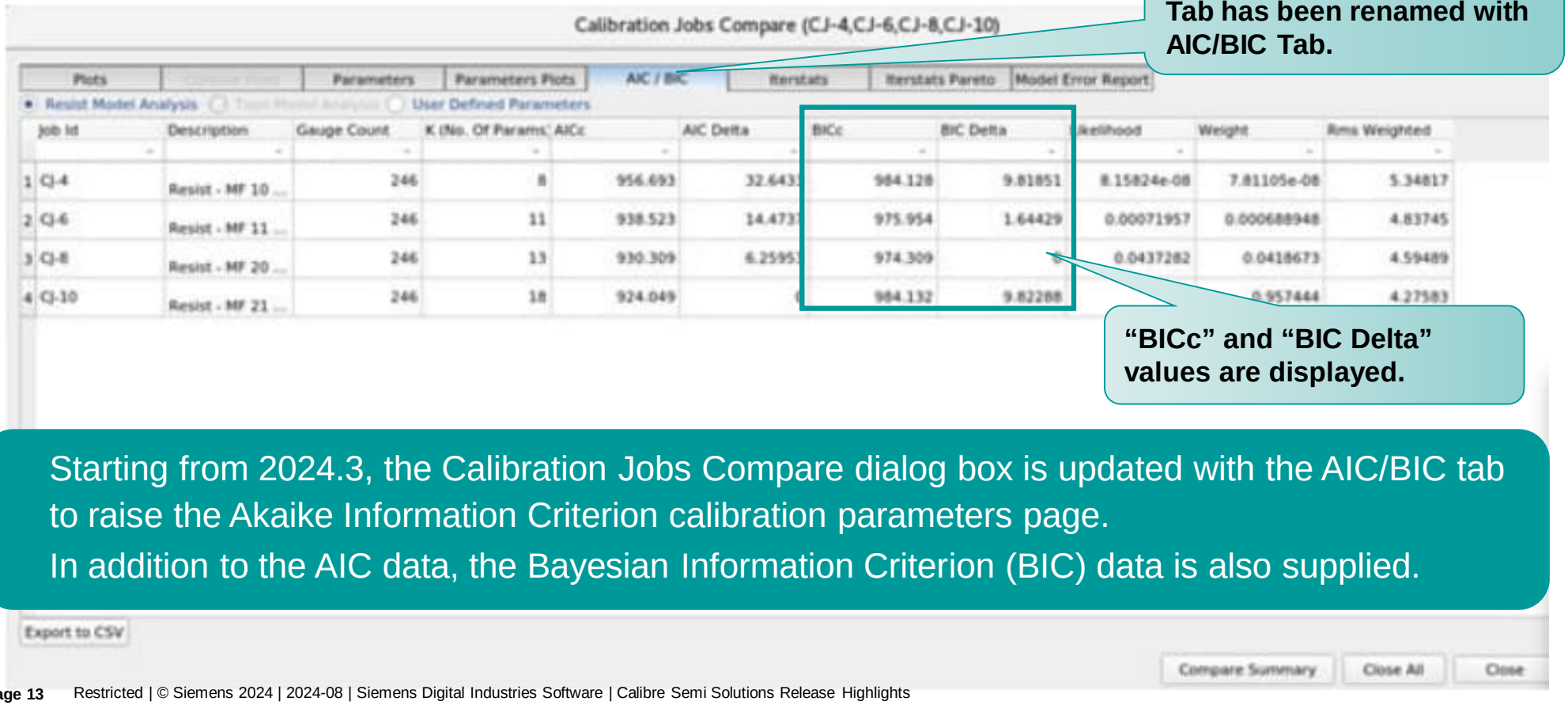
New Job Type in Calibre pxOPC

- New `Reopen` job in Calibre pxOPC reinitializes main features while fixing the assist features.
- New `Spa` job in Calibre pxOPC can be used to replace the `Correct` job if the `Correct` job removes features too aggressively while suppressing extra printing.

Default Iterations		
Job	Standalone pxOPC	LPE-Driven pxOPC
Reopen version 1	10	10
Reopen version 2	20	20
Spa	20	20

- Calibre pxOPC adds support of the `Refine` job type in Calibre LPE runs.
- There are changes the `Finalize` job type to optimize main features while freezing SRAFs in addition to other performance changes.

New Model Testing and Selection Tool - Bayesian Information Criterion (BIC)

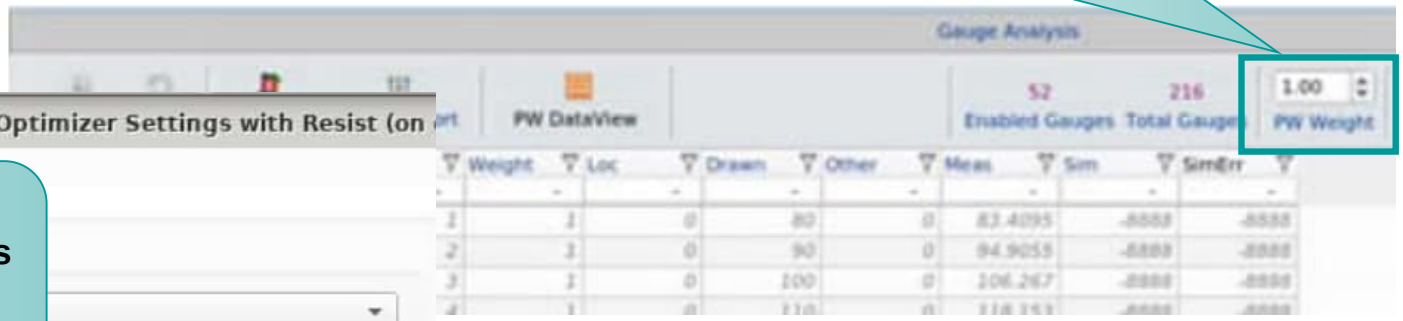


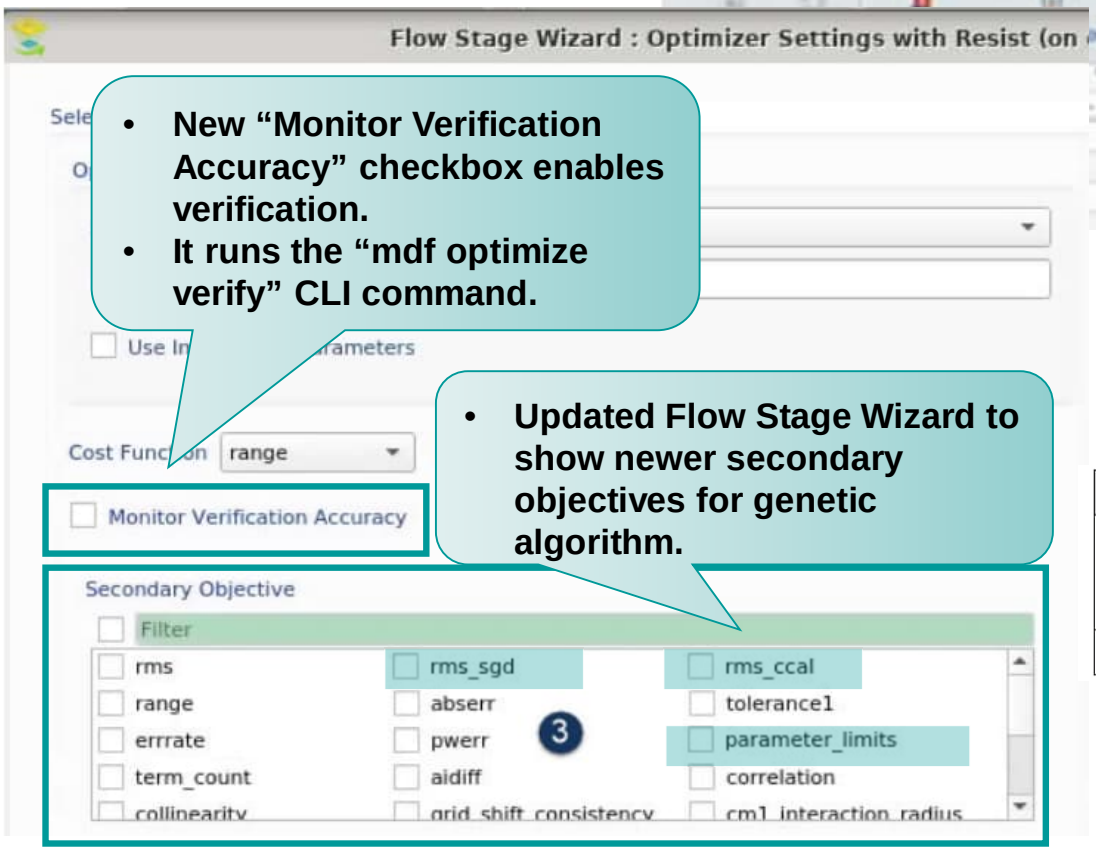
Starting from 2024.3, the Calibration Jobs Compare dialog box is updated with the AIC/BIC tab to raise the Akaike Information Criterion calibration parameters page.

In addition to the AIC data, the Bayesian Information Criterion (BIC) data is also supplied.

Calibre nmModelflow GUI Updates and New Default

- Updated Gauge Analysis Tab to specify PW Weight value.





- New "Monitor Verification Accuracy" checkbox enables verification.
- It runs the "mdf optimize verify" CLI command.

- Updated Flow Stage Wizard to show newer secondary objectives for genetic algorithm.

Keyword or Variable	Previous Default	New Default
Calibre nmModelflow thresholdtolerance parameter	1.5	5
Reason for Change: Results in better models with less extra printing.		

- New default value for resist model calibration.

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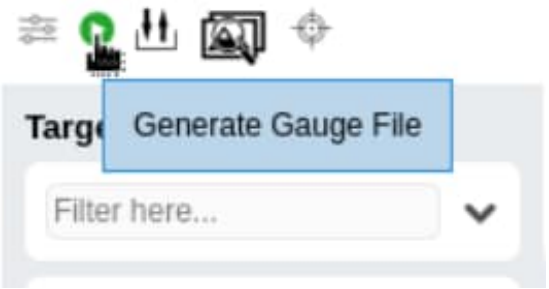
Calibre SEMSuite New Features

- In the Raw Data Filtering (RDF) tool, new options are available in the Gauge File Generation dialog box to extend/double the gauge length for 2D features and to select the max length across dose/focus.

  : Object to open the Gauge File Generation dialog box.



- In the Contour Data Flow (CDF) tool, several new features are available:
  - New features in CDF Runs Browser to import run/setup settings from previous runs/setups.
  - New options in CDF Runs Browser to import the run decisions from the selected run/setup combination.
  - New right-click option for classifying images in the Repeat Run Metrics table.
  - New Re-run Options in CDF Runs Browser:
    - Contours Averaging On
    - EPE Measurements Generation
    - Merged Layout Generation

  : Object to re-run the contour extraction run with some changes.

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Calibre SEMSuite New Commands

- New command to activate turning of an interpolation factor in the search space during Auto SetupTuning.
  - The default behavior is tuning deactivated.

interpolation_factor_tuned false | true

- New command to specify the type of image format and compression for all images saved during contour extraction.
  - By default, the tool saves images in the JPEG format which uses higher compression and occupies less disk space

output_image_format jpg | bmp

- New command to control the saving of intermediate contours during contour extraction.
  - By default, the tool saves intermediate contours.

dump_intermediate_contour true | false

- Two new commands in CDF API when applying a series of transformations to the input SEM image before contour extraction.
  - `NoiseRemoval_12` performs noise removal while preserving edges.
  - `NoiseRemoval_13` performs noise removal using a filter that extracts or enhances the ridges in images.

preprocess_step NoiseRemoval_12

preprocess_step NoiseRemoval_13

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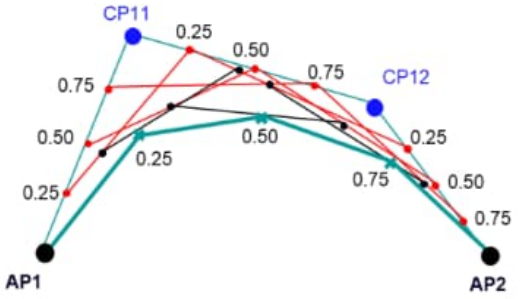
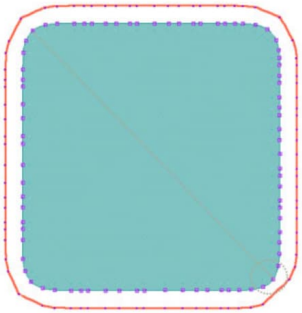
Spline-Based Curvilinear MPC and multi-PNG File Support

- Industry-wide effort: The migration from the piece-wise linear polygons to piece-wise Bezier.
- Spline-based nmCLMPC acts on piecewise Bezier curves using anchor point sets for correction.
- Spline-based nmCLMPC advantages: Output shapes are less prone to show high frequency noise and there is file size reduction on output files.



Cubic Bezier spline curve formation



Red: Results of Spline- Based nmCLMPC

- Users can now specify a root directory for multi-PNG files (mPNG) when loading model information for PEC, FEC and LEC.

pec_model_map <pec model file> **pec_map** <mPNG directory> **-mpng**

fec_model_map <fec model file> **fec_map** <mPNG directory> **-mpng**

lec_model_map <lec model file> **lec_map** <mPNG directory> **-mpng**

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New and Updated Commands in Calibre Cluster Manager (CalCM)

New Commands for Performance Monitoring

- Users can now monitor performance with the three new performance monitoring message commands to start and stop the performance monitoring, as well as to display the performance metrics.
  - `perfmon_start [sample_period]`
  - `perfmon_stop`
  - `perfmon_view`

```
$ ./calcm_send_message perfmon_view
CalCM performance metric
Performance monitor start time: Thu May  9 17:31:32
End time of last sample period: Thu May  9 17:35:52
Sample period: 10 seconds
Next sampling : 8 seconds remained
-------------------------------------------------------------------
Metrics                          Last  Max   Min   Avg    Total
-------------------------------------------------------------------
Jobs submitted                   5     5     0     2      5
Jobs dispatched                  5     5     0     0      5
Jobs completed                   2     2     0     1      2
cjobs queries                    0     0     0     0      0
chosts queries                   0     0     0     0      0
cqueues queries                  0     0     0     0      0
-------------------------------------------------------------------
Scheduler Metrics                Last  Max   Min   Avg    Total
-------------------------------------------------------------------
Scheduling interval in second(s) 2     2     1     1
Total updated cycles                                    8
-------------------------------------------------------------------
```

Example output from performance monitoring

Updated Command in CalCM

- The `JOB PRE_CHECK_EXEC_IN_QUEUE` command is renamed to `JOB PRE_EXEC_IN_QUEUE`. It also now includes a new argument to specify parameters to pass into the script.

JOB PRE_EXEC_CHECK_IN_QUEUE filename [**parameters**]

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Updates for CalScope

New Keyword in CalScope Configuration File

- Users can now add a keyword to the CalScope configuration file to discard duplicate dmesgs or to collect all dmesgs during dmesg collection.
- Example below specifies 1 to discard duplicate dmesgs. This is default behavior.

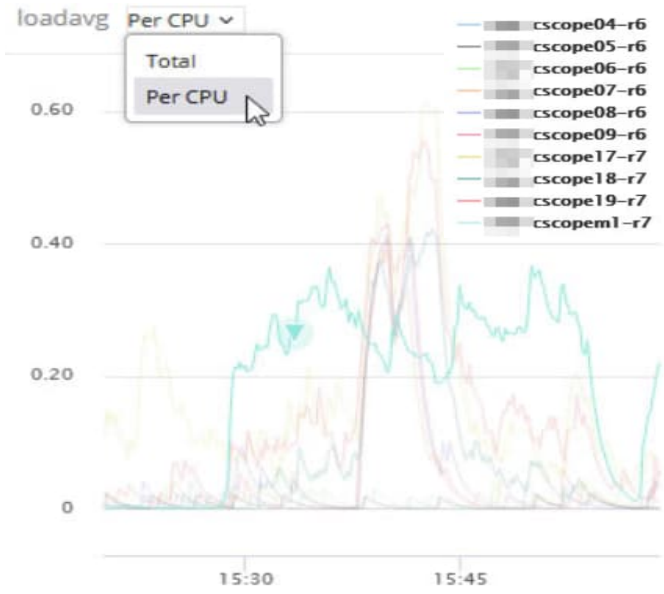
```
hw_monitor:
        collect_dmesg: 1
```

- Example below specifies 2 to collect all dmesgs including duplicates.

```
hw_monitor:
        collect_dmesg: 2
```

New Option to View CalScope Results Per CPU

- Users can now view CalScope's plots either by total value or per CPU core by selecting it from the dropdown menu above the plot.



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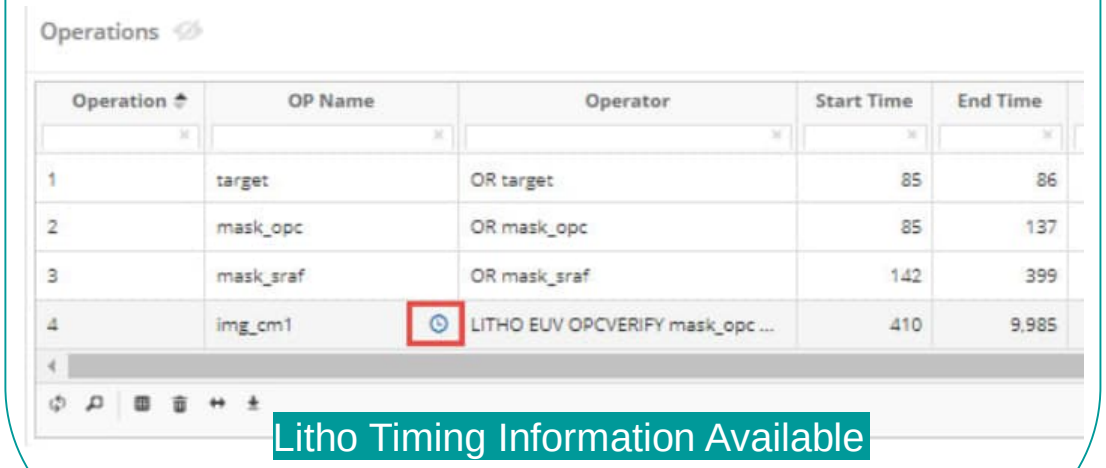
Updates for CalDash

New Aggregation Function in CalDash

- Users can now specify which aggregation function to use when aggregating hardware metrics data by using `-aggr` keyword.
- Listed below are the available choices:
  - `max` — Aggregates using the maximum values (Default).
  - `min` — Aggregates using the minimum values.
  - `avg` — Aggregates using the average values.
  - `lttb` — Aggregates using the LTTB (Largest Triangle Three Buckets) function.
  - `none` — Does not aggregate values.

New Access to Litho Timing Reports

- Users can now access litho timing reports, if available, from the CalDash dashboard.
- When there is litho timing information, the OP Name column of the Operations table displays a clock icon.



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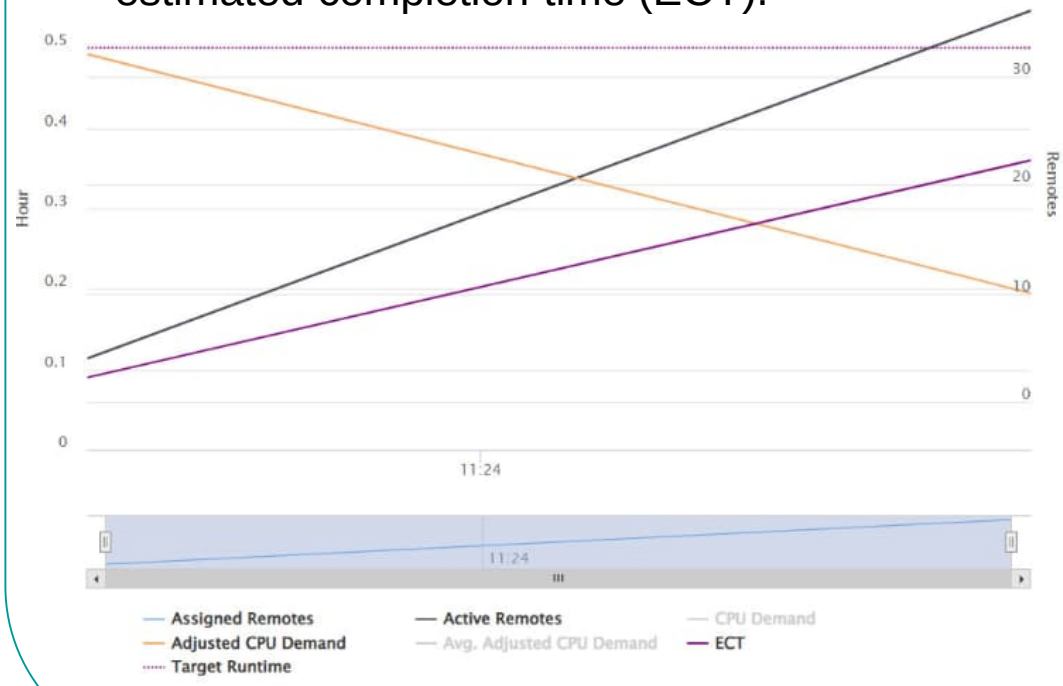
Additional Updates for CalCM+

New Prediction-Based TAT Control

- Users can now use prediction-based TAT control for more efficient resource allocation based on runtime prediction.
- Use the following new options to setup TAT control:
  - New `TATCONTROL` argument in calcm_rmanager_app.tcl to enable the control.
  - New `JOB TARGETRUNTIME` configuration statement in the job configuration file to set the target runtime.
  - New `adjust_targetruntime` message command to adjust the target runtime.

New Estimated Completion Time Plot

- For FullScale jobs with ERT (estimated remaining time) data, the job plots in CalCM now show the estimated completion time (ECT).



ECT Plot for FullScale with ERT

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Changes for Accessing Calibre Product Documentation

- The default option is accessing product documentation from Support Center.
- New option is available to configure a documentation proxy for viewing documentation on Support Center without needing a Support Center account.
- Alternatively, users have the option to download and set up the Siemens Documentation Server to view the documentation package on local netw
- This change provides a unified and consistent method for accessing product documentation for all Siemens products and reduces the size of the software download.
- The Siemens EDA documentation InfoHub is no longer available, and documentation is not included in the Calibre software installation directory.

Thank You!

Where today meets tomorrow.

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